

Layered Model for Radiation-Induced Chemical Evolution of Icy Surface Composition and Dynamics on Kuiper Belt and Oort Cloud Bodies

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The diversity of albedos and surface colors on observed Kuiper Belt and Inner Oort Cloud objects remains to be explained in terms of competition between primordial intrinsic versus exogenic drivers of surface and near-surface evolution. Earlier models have attempted without success to attribute this diversity to the relations between surface radiolysis from cosmic ray irradiation and gardening by meteoritic impacts. A more flexible approach considers the different depth-dependent radiation profiles produced by low-energy plasma, suprathermal, and maximally penetrating charged particles of the heliospheric and local interstellar radiation environment. Generally red objects of the dynamically cold (low inclination, circular orbit) Classical Kuiper Belt might be accounted for from erosive effects of plasma ions and reddening effects of high energy cosmic ray ions, while suprathermal keV-MeV ions could alternatively produce more color neutral surfaces. The deepest layer of more pristine ice can be brought to the surface from meter to kilometer depths by larger impact events and potentially by cryovolcanic activity. The bright surfaces of some larger objects, e.g. Eris, suggest ongoing resurfacing activity. Cycles of atmospheric formation and surface freezeout can further account for temporal variation as observed on Pluto. The diversity of causative processes must therefore be understood to account for observationally apparent diversities of the object surfaces.

Presented at Western Pacific Geophysics Meeting, Taipei, Taiwan, June 22-25, 2010.